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Changing Habitats in the Platte River Valley of Nebraska

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ABSTRACT — We summarized data on habitat changes in segments of the North Platte and Platte Rivers, Nebraska, by examination of aerial photographs taken in 1938, 1965, 1969, and 1982. Our data are presented alongside data from other sources to view habitat changes since early settlement by Europeans. An 85-91% reduction in the area of the active channel along some segments has occurred. The channel has been transformed from nearly treeless to a mostly wooded environment. There has been a 23-45% loss of wetland meadows between 1938-1982, and a 12-73% increase in cropland during the same period.

Water development projects, such as reservoirs and diversion canals, in Colorado, Wyoming, and Nebraska have reduced stream flows in the Platte River system (Fig. 1). Such reductions have altered the habitats of some migratory birds, a concern of various parties (Currier et al. 1985, U.S. Fish and Wildlife Service 1981, VanDerwalker 1988).

Up to 70% of the flow (as measured at the U.S. Geological Survey's gage at Overton, NE) along the "Big Bend Reach" (Lexington to Chapman) of the Platte River has been lost since the mid-nineteenth century (Williams 1978). This estimate is probably low, because considerable water development occurred prior to installation of flow gaging stations and during the years of gaging station records that were used to estimate pre-development flows.

The impoundment and diversion of water in the Platte River system has led to the habitat changes visible in photographs taken between the late nineteenth century and today (Eschner et al. 1981, Williams 1978). The precise hydrological and biological mechanisms behind habitat changes are not altogether clear. However, it is generally accepted that water flow reductions have contributed to the current state of habitats along segments of the North Platte and Platte Rivers that we and others have studied. Flow reductions have allowed woody vegetation to develop on the streambed and lowered the water table, thereby accelerating the drainage and agricultural conversion of wetlands adjacent to the river (U.S. Fish and Wildlife Service 1981, 1987a, 1987b; Currier et al. 1985).

Groundwater withdrawal, evapotranspiration, and channel incision also may have influenced the water table, but these are fairly recent events of the past 30-50 years. Whereas seasonal declines in the water table occur when river flow drops or ceases in mid to late summer, flows also drop because of irrigation pumping close to the river. Lappula et al. (1979) indicate that permanent lowering

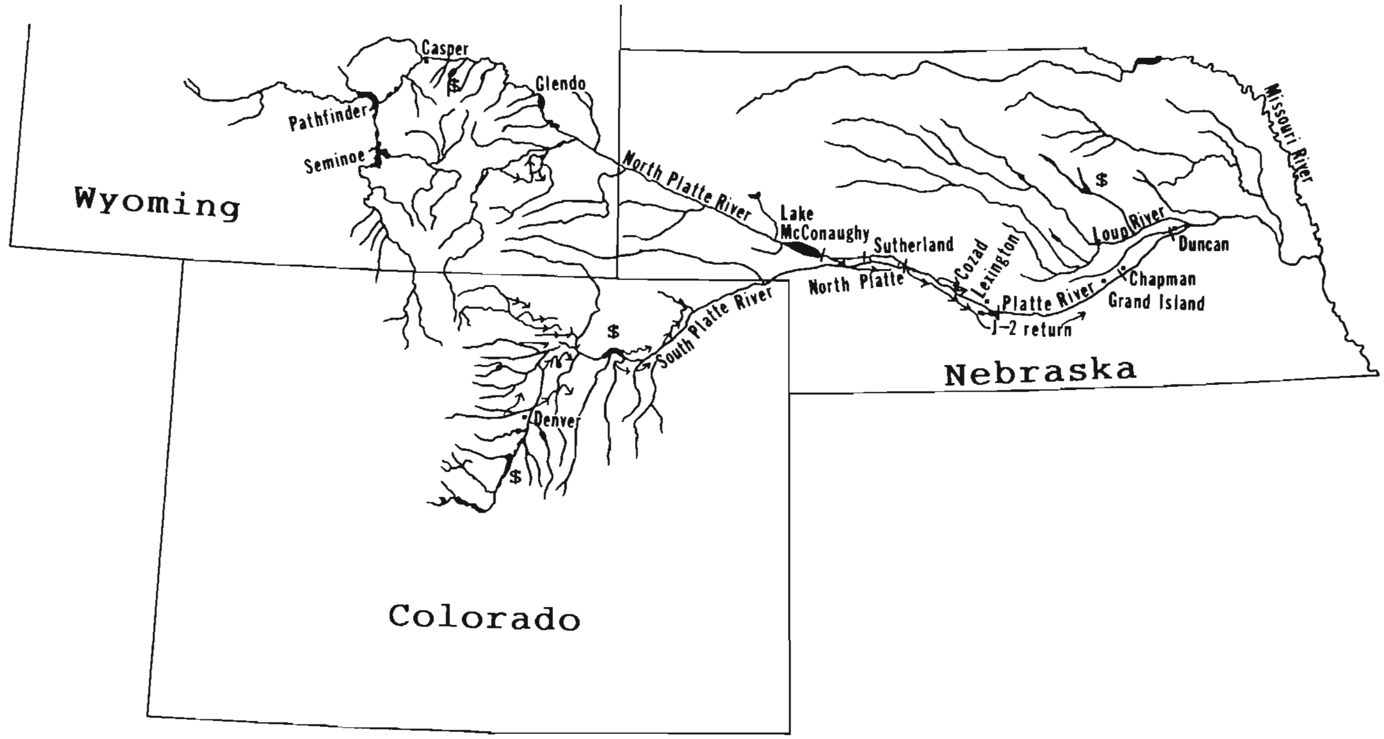

Figure 1. Many of the existing (solid, →) and proposed water development projects ($) in the Platte River Basin.

of river flows in the Big Bend Reach may already be occurring due to high ground-water pumping. Evapotranspiration from riparian forests also may decrease flows, although Nagel and Dart (1980) estimated that evapotranspiration rates from the riparian forest were probably no greater than evapotranspiration rates from the native grassland and active channel habitat it replaced. As sediment is trapped in upstream reservoirs, there is some evidence that the streambed is degrading (O'Brien and Currier 1987). A lower streambed leads to lower surface water stage and in turn lower ground water levels.

During the past 80 years, woody vegetation has developed across wide expanses of the streambed. Historic observations, plat records, and photographs describe a wide and nearly treeless environment in much of the Platte River system during the nineteenth century. Such observations have been cited frequently in recent hydrologic and morphologic studies of the North Platte and Platte Rivers (Currier et al. 1985, Eschner et al. 1981, Williams 1978). River channels have narrowed tremendously (Lyons and Randle 1988), and presently, much of the river is dominated by woodlands and surrounded by croplands.

Dams have reduced dramatically the amount of alluvium reaching the Big Bend Reach (Lyons and Randle 1988). Reduced peak flows are no longer sufficient to move the volume of alluvial sediment needed to maintain a wide and shallow channel and to scour seedlings (O'Brien and Currier 1987). Moreover, seasonally high flows that fill the river channel for a few weeks or 1-2 months at a time were once significant in scouring vegetation and moving alluvium.

As a result, open stretches of river channel, predominated by shallow water habitats and vegetation-free habitat and adjacent wetland meadows, have decreased greatly. This change has reduced the nesting, roosting, courtship, and feeding habitat of some migratory birds, including threatened and endangered species (U.S. Fish and Wildlife Service 1981). Flow reductions and channel morphology changes have had an adverse impact on many fish species (Missouri River Basin Commission 1975).

Even with the habitat losses described above, the Big Bend reach of the Platte River still provides important habitat for migratory birds of the Central Flyway. During migration, birds funnel through the Big Bend reach, which is the waist of the hourglass-shaped migration route (Frith 1974). The importance of the Big Bend reach and segments of the North Platte River for migrating sandhill cranes (*Grus canadensis*) is well known (Krapu et al. 1982, Krapu 1987). Nearly 450,000 sandhill cranes (80% of the midcontinent population) spend 6-8 weeks roosting in the river and feeding in adjacent wetland meadows and agricultural land. Whooping cranes (*Grus americana*) also roost along the Big Bend reach during migration, and the threatened bald eagle (*Haliaeetus leucocephalus*) winters in the area (U.S. Fish and Wildlife Service 1981). The endangered interior population of the least tern (*Sterna antillarum*) and the threatened piping plover (*Charadrius melodus*) nest along the Big Bend Reach (Sidle et al. 1988, U.S. Fish and Wildlife Service 1988).

Considerable discussion has focused on the amount of habitat loss in the Platte River System since settlement. Because there are many proposed water development projects (Faanes, in press; U.S. Fish and Wildlife Service 1987a, 1987b) and discussions on altering current instream flow regimes, habitat change may continue. Public regulating agencies, project proponents, and the citizenry require an adequate understanding of the causes and extent of habitat changes to make the best decisions regarding water development in the Platte River System.

In this paper, we quantify historical habitat changes on segments of the Platte and North Platte rivers, using our own analyses of aerial photographs and analyses from other sources. The objective of this study and review is to compare data on habitat changes in the Platte River system between Duncan and Lake McConaughy.

METHODS

Various methods have been used by Williams (1978), Eschner et al. (1981), Peake et al. (1985), Currier et al. (1985), and Krapu et al. (1987) to describe the changes in habitat along certain river segments in the Platte River system (Table 1). These changes have included channel width changes, total area changes, and changes based on partial coverage of river channel, riparian forest, wetland meadows, and cropland. Data from these studies and our analysis were converted to hectares per river km for each habitat component. Estimates were then expanded to each selected river segment. Transect widths of river channels were converted to area measurements by multiplying average width by the length of the segment. Where necessary, segment lengths were adjusted to make habitat measurements comparable. Details of each study are provided below.

Riparian forest comparisons were restricted to the floodplain, essentially within the 1860s channel boundary depicted on U.S. Government land survey maps, and lands immediately adjacent to the former channel. Wetland meadows were identified as grasslands with dissected ribbon-like drainage patterns on the river floodplain. Under the Cowardin et al. (1979) classification, wetland meadows are palustrine emergent wetlands. They are seasonally flooded and support a persistent, perennial vegetation. *Carex* spp., *Scirpus americanus*, *Eleocharis* spp., *Panicum virgatum*, and *Andropogon gerardi*, are important wetland meadow species (Currier 1982; Currier, in press). Other characteristic species are *Phyla lanceolata*, *Polygonum* spp., *Vernonia fasciculata*, *Liatris pycnostachya*, and *Helenium autumnale*. The meadows occur on shallow, poorly drained alluvial soils.

This Study

In this study, we examined aerial photographs (1938, 1965, 1969) of 3.2-km segments (about 20% coverage) of the Platte and North Platte rivers to compare changes in channel area, riparian forest, cropland, and wetland meadows. Total area coverage in the segments was converted to total coverage for each river segment on a proportional basis. The wetland meadow acreage (1982 photographs) presented by Currier et al. (1985) was refined in our analysis. Wetland meadows originally were determined by Currier et al. (1985) as any grassland within the floodplain boundary of the Platte. Some wetland meadows were inadvertently eliminated using this criterion, depending upon where the floodplain boundary was drawn. To rework this data, topography was used to

Table 1. Coverage area and methods used by various authors to assess channel and riparian habitat changes along the Platte River system in Nebraska.

Source	River Segments	Year	Data Base	Habitat Assessment
This study	Chapman to Lake McConaughy	1938 1965/69	Aerial photographs Aerial photographs	Partial coverage of channel, cropland, forest and wetland meadows in 3.2-km segments
This study	Chapman to J-2 Return & North Platte to McConaughy	1982	Aerial photographs	Continuous coverage, total wetland meadow area
ECON, Inc. (1977a, b)	Chapman to Lake McConaughy	1976/77	Aerial photographs	Continuous coverage of channel area, riparian forest, wetland meadow, and cropland
Williams (1978)	Chapman to Lake McConaughy	1865 1938 1965	Land survey maps Aerial photographs Aerial photographs Aerial photographs	Partial coverage on transects — channel width measurements
Eschner et al. (1981)	Duncan to North Platte	1860 1938/41 1950/51 1957 1963/64 1969/70 1978/79	Land survey maps Aerial photographs Aerial photographs Aerial photographs Aerial photographs Aerial photographs Aerial photographs	Partial coverage on transects — channel width measurements
Peak et al. (1985)	Chapman to North Platte	1860 1938 1957 1983	Land survey maps Aerial photographs Aerial photographs Aerial photographs	Continuous coverage, total area of channel, riparian forest
Currier et al. (1985)	Chapman to J-2 Return & North Platte to Sutherland	1982	Aerial photographs	Continuous coverage, total area of channel, riparian forest
Currier et al. (1985)	Chapman to J-2 return	1938 1969 1982	Aerial photographs Aerial photographs Aerial photographs	Partial coverage of channel area, riparian forest, 3.2 km segments
Krapu et al. (1987)	Chapman to J-2 return & North Platte to Sutherland	1979	Aerial photographs	Continuous coverage in sandhill crane staging areas; channel area, riparian forest, wetland meadows, and cropland

eliminate grasslands on upland sites, with the remainder being classed as wetland meadow.

ECON, Inc. (1977a, 1977b)

Under a contract with the U.S. Fish and Wildlife Service, ECON, Inc. (1977a, b) assessed the extent of channel area, forest, wetland meadow, and cropland along the Platte and North Platte rivers and adjacent floodplain (100% coverage), using 1976 and 1977 aerial photographs.

Williams (1978)

Williams (1978) examined 1938 and 1965 aerial photographs and 1865 land survey maps to measure changes in channel width. Transects were measured every 19.3 km between Grand Island and the Wyoming state line. Only active channel measurements were made. We converted average channel width data to area measurements based on river segment length.

Eschner et al. (1981)

A transect technique similar to Williams (1978) was used by Eschner et al. (1981) to study active channel width changes. Eschner et al. (1981) examined 1860 land survey maps and aerial photographs (1938, 1941, 1950-51, 1957, 1963-64, 1969-70, 1978-79) of five 5-km river segments in the Grand Island to J-2 return reach, Duncan to Grand Island, and J-2 return to North Platte segments. We converted average width measurements to active channel area.

Peake et al. (1985)

Continuous total area coverage of the channel and riparian forest was measured by Peake et al. (1985) using 1860s land survey maps and 1938, 1957, and 1983 aerial photographs. Riparian forest changes were recorded only within the 1860s channel boundary. Some of the original maps produced by Peake et al. (1985) were re-measured to correct an error reported in active channel changes from the 1860s to 1983.

Currier et al. (1985)

Currier et al. (1985) reported continuous total area coverage of channel, riparian forest, wetland meadows, and cropland based on examination of 1982 photographs covering an area 5.6 km beyond the outermost banks of the river channel. We re-analyzed wetland meadow data from Currier et al. (1985) as described under This Study. Cropland data in Currier et al. (1985) extended beyond the geographic boundaries in our analysis and therefore could not be used in a direct comparison.

A separate analysis from Currier et al. (1985) also was used for comparison. Aerial photographs (1938, 1969, 1982) of three 3.2-km segments of the river were used to assess changes in active channel area and riparian forest. Data from these segments were converted on a proportional basis to total area measurements in the Chapman to J-2 return segment of the Platte River.

Krapu et al. (1987)

Krapu et al. (1987) examined 1979 aerial photographs (continuous coverage) to assess channel area, riparian forest, wetland meadows, and cropland in sandhill crane staging areas. We adjusted cropland boundaries to be comparable with our analysis, and converted the data on a proportional basis to total area measurements for each river segment. Wetland meadows probably were overestimated in the total area conversion, because sampling by Krapu et al. (1987) was biased towards crane staging areas where adjacent wetland meadows are more abundant than elsewhere in the Platte River system.

RESULTS AND DISCUSSION

Changes in active channel area are presented in Table 2. Estimates from dif-

Table 2. Changes in the active channel (including sandbars) along the North Platte and Platte Rivers (Lake McConaughy to Duncan), Nebraska, 1860-1983.

River Segment	Year	Approximate ha/river km	Approximate ha of active channel	Source
North Platte River — Sutherland to Lake McConaughy (56 km)	1865	88	4,915	Williams (1978)
	1938	47	2,649	Williams (1978)
	1965	10	538	Williams (1978)
	1976	13	751	ECON, Inc. (1977a)
North Platte River — North Platte to Sutherland (34 km)	1865	90	3,076	Williams (1978)
	1938	48	1,649	Williams (1978)
	1938	32	1,096	This study
	1965	8	280	Williams (1978)
	1965	10	357	This study
	1976	13	433	ECON, Inc. (1977a)
	1982	16	561	Currier et al. (1985)
Platte River — J-2 Return to North Platte (109 km)	1860	117	12,714	Eschner et al. (1981)
	1860	121	13,153	Peake et al. (1985)
	1865	120	13,072	Williams (1978)
	1938	102	11,118	Eschner et al. (1981)
	1938	76	8,311	Williams (1978)
	1938	57	6,247	This study
	1938	61	6,632	Peake et al. (1985)
	1951	20	2,229	Eschner et al. (1981)
	1957	11	1,238	Eschner et al. (1981)
	1957	16	1,734	Peake et al. (1985)
	1963	11	1,211	Eschner et al. (1981)
	1965	6	659	Williams (1978)
	1969	11	1,238	Eschner et al. (1981)
	1969	11	1,183	This study
	1976	17	1,871	ECON, Inc. (1977a)
	1979	11	1,211	Eschner et al. (1981)
	1983	17	1,871	Peake et al. (1985)

Table 2. (continued)

River Segment	Year	Approximate ha/ river km	ha of active channel	Source
Platte River — Chapman to J-2 Return (143 km)	1860	138	19,702	Eschner et al. (1981)
	1860	122	17,468	Peake et al. (1985)
	1865	128	18,297	Williams (1978)
	1938	96	13,795	Eschner et al. (1981)
	1938	100	14,371	Wiliams (1978)
	1938	68	9,544	Currier et al. (1985)
	1938	70	9,976	This study
	1938	70	10,049	Peake et al. (1985)
	1951	57	8,212	Eschner et al. (1981)
	1957	61	8,680	Eschner et al. (1981)
	1957	46	6,555	Peake et al. (1985)[1]
	1963	41	5,943	Eschner et al. (1981)
	1965	65	9,293	Williams (1978)
	1969	38	5,511	Eschner et al. (1981)
	1969	28	3,998	Currier et al. (1985)
	1969	31	4,502	This study
	1976	38	5,403	ECON, Inc. (1977a)
	1979	35	4,970	Eschner et al. (1981)
	1979	22	3,170	Krapu et al. (1987)
	1982	28	4,070	Currier et al. (1985)
	1983	33	4,682	Peake et al. (1985)
Platte River — Duncan to Chapman (84 km)	1860	82	6,902	Eschner et al. (1981)
	1941	60	5,029	Eschner et al. (1981)
	1950	54	4,545	Eschner et al. (1981)
	1957	52	4,356	Eschner et al. (1981)
	1964	44	3,746	Eschner et al. (1981)
	1970	42	3,556	Eschner et al. (1981)
	1978	41	3,430	Eschner et al. (1981)

ferent sources show variance in the measurement of active channel, but the trend from the 1860s clearly has been downward. Measurements based on transect data (Williams 1978, Eschner et al. 1981) overestimate the actual channel area measured by Peake et al. (1985), Currier et al. (1985) and ourselves (Fig. 2). Thus, estimates of active channel area along the North Platte River based primarily on Williams (1978) and estimates in the Duncan to Chapman segment (Eschner et al. 1981) also are probably high. The greatest decline in active channel has occurred on the North Platte River between North Platte and Lake McConaughy (85%) and between the J-2 return and North Platte (85-91%). Between Chapman and the J-2 return, the area of highest sandhill crane and waterfowl concentrations (U.S. Fish and Wildlife Service 1981), channel losses have been up to 73%.

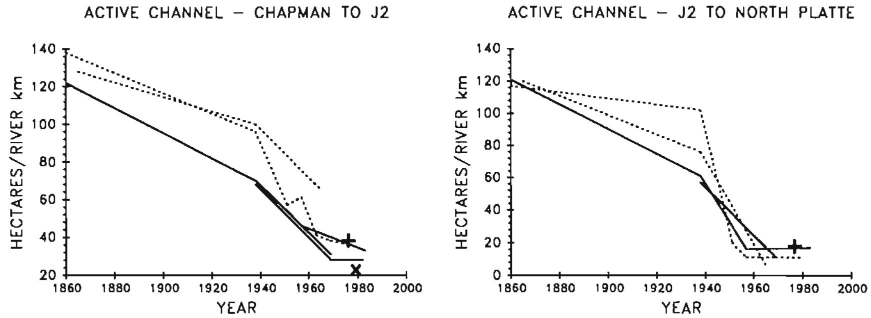

Figure 2. Active channel changes since the 1860s. Dotted lines represent data based on transect measurements (Williams 1978, Eschner et al. 1981) and probably overestimate actual channel area. Solid lines represent our study and other studies using total channel measurements. Symbols represent point data from ECON, Inc. (1977a) (+) and Krapu et al. (1987) (x).

Active channel losses directly parallel increases in riparian forests (Table 3). Since 1938, riparian forest has increased from 29% to 75%. The average density of forest, however, is much greater above the J-2 return (116 ha/km) than below (79 ha/km). Since 1938, major changes in river flows have occurred as a result of the construction of reservoirs such as Lake McConaughy, and Seminoe and various water diversion projects. Much of Lake McConaughy's storage is diverted into a canal system for irrigation and power generation. The canal system allows North Platte River flows to by-pass the J-2 to North Platte segment of the Platte River. Along this segment, forest development has occurred at an accelerated rate (Fig. 3). A portion of flows (what has not been used for irrigation or power) from the canal re-enters the Platte River at the J-2 return.

Wetland meadow declines also have been substantial (23-45%) since 1938 (Table 4). They have been converted to sand and gravel pits, housing, and roads such as the Interstate-80 highway. Their conversion to cropland (Table 5) usually requires construction of drainage ditches and land-levelling. Most conversion occurred between 1965 and 1976 when grain prices and farm income were high relative to land and conversion costs. Wetland meadow destruction along the North Platte River since 1938 has been slower (23-33%), probably because much of the cultivatable land in this segment was converted and under gravity irrigation prior to 1938.

The habitat changes along the Platte River system in Nebraska follow in the wake of extensive water development in the Platte River Basin. Similar development and habitat changes have been reported along other rivers of the Great Plains (Stinnett and Smith 1988, Tomelleri 1984). It is easy to tabulate these riverine habitat losses. When future generations peer back into the history of the prairie, data on wetland and prairie destruction will be bountiful. The same

Table 3. The development of riparian forest along the North Platte and Platte Rivers (Sutherland to Chapman), Nebraska, 1860-1983.

River Segment	Year	Approximate ha/river km	Approximate ha of riparian forest	Source
North Platte River — North Platte to Sutherland (34 km)	1860	0	0	Assumed negligible
	1938	55	1,887	This study[1]
	1965	76	2,592	This study[1]
	1976	92	3,127	ECON, Inc. (1977a)
	1979	71	2,431	Krapu et al. (1987)
	1982	66	2,247	Currier et al. (1985)
Platte River — J-2 Return to North Platte (109 km)	1860	0	0	Peake et al. (1985)[2]
	1938	65	7,100	Peake et al. (1985)[2]
	1938	86	9,384	This study[1]
	1957	103	11,255	Peake et al. (1985)[2]
	1965	127	13,815	This study[1]
	1976	128	13,980	ECON, Inc. (1977a)
	1983	105	11,503	Peake et al. (1985)[2]
Platte River — Chapman to J-2 Return (143 km)	1860	0	0	Peake et al. (1985)[2]
	1938	47	6,699	This study[1]
	1938	32	4,538	Peake et al. (1985)[2]
	1957	53	7,563	Peake et al. (1985)[2]
	1969	80	11,490	This study[1]
	1976	76	10,877	ECON, Inc. (1977a)
	1979	67	9,545	Krapu et al. (1987)
	1982	76	10,877	Currier et al. (1985)
	1983	82	11,705	Peake et al. (1985)[2]

[1]Includes all forest in river valley.
[2]Includes 1860 river channel only.

generations may peer across the Platte River valley and wonder what their ancestors did about it.

Not so long ago there was little recourse and no abundant foresight to curtail the destruction of wetlands. Today, the cause of wetland protection is international in scope. The challenge before public agencies and private organizations today is to use all of those hard-fought-for laws and regulations to protect remaining wetlands and grasslands in the Platte River valley of Nebraska.

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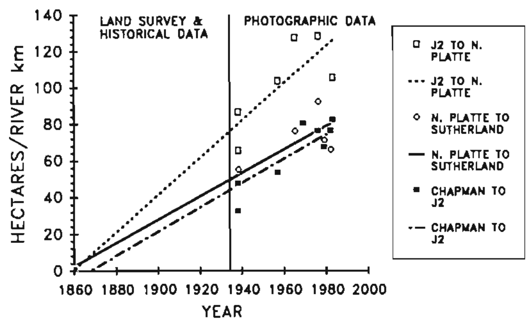

Figure 3. Least squares regression of riparian forest changes on various segments of the Platte and North Platte Rivers. Forest development has occurred at an accelerated rate in the J-2 return to North Platte segment whose flows have been greatly reduced by a diversion canal system which returns a portion of the flow at the J-2 return.

Table 4. The decline of wetland meadows along the North Platte and Platte Rivers (Lake McConaughy to Chapman), Nebraska, 1938-1983.

River Segment	Year	Approximate ha/ river km	ha of wetland meadow	Source
North Platte R. — Sutherland to McConaughy (56 km)	1976	162	9,079	ECON, Inc. (1977a)
	1977	166	9,292	ECON, Inc. (1977b)
North Platte River — N. Platte to Sutherland (34 km)	1938	384	13,071	This study
	1965	360	12,238	This study
	1976	257	8,753	ECON, Inc. (1977a)
	1982	297	10,098	This study
Platte River — J-2 Return to North Platte (109 km)	1938	405	44,196	This study
	1965	360	39,243	This study
	1976	260	28,400	ECON, Inc. (1977a)
Platte River — Chapman to J-2 Return (143 km)	1938	367	52,551	This study
	1969	325	46,500	This study
	1976	211	30,147	ECON, Inc. (1977a)
	1979	248	35,514	Krapu et al. (1987)
	1982	201	28,779	This study

Table 5. The increase of cropland along the North Platte and Platte Rivers (Sutherland to Chapman), Nebraska. 1938-1979.

River Segment	Year	Approximate ha/river km	Approximate ha of cropland	Source
North Platte River — North Platte to Sutherland (34 km)	1938	109	3,714	This study
	1965	121	4,113	This study
	1979	122[1]	4,164	Krapu et al. (1987)
Platte River — J-2 Return to North Platte (109 km)	1938	146	15,961	This study
	1969	168	18,328	This study
Platte River — Chapman to J-2 Return (143 km)	1938	144	20,566	This study
	1969	164	23,484	This study
	1979	249[1]	35,586	Krapu et al. (1987)

[1]Adjusted to reflect the cropland boundary used in this study.

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